

THERMOCHROMIC COATING FOR OUTDOOR USE AND METHOD OF APPLYING

RELATED CASES

This invention is described in my copending Provisional
5 Patent Application ser. No. 60/059,593, filed September 23, 1997
and now _____.

FIELD OF INVENTION

10 This invention relates to thermochromic materials and is
particularly directed to improved thermochromic liquid crystal
coatings for use in outdoor and abrasive atmospheres, together
with suitable methods for applying such coatings.

PRIOR ART

15 Thermochromic materials, such as liquid crystals, have been
known for many years. However, the use of such materials has been
limited to so-called "mood rings", greeting cards and the like,
due to the fact that the prior art thermochromic materials have
been jellylike in substance and were not able to withstand
20 exposure to outdoor conditions. Also. they were easily rubbed off
by something brushing against it. Heretofore, thermochromic
materials have been provided in sheet form on a supporting layer
of transparent material, such as mylar, to prevent the sheet of
thermochromic material from tearing or becoming otherwise dam-
25 aged. Also, once applied to a substrate, the mylar served to
protect the thermochromic sheet. However, it has been difficult

to make the mylar adhere to the thermochromic material and the mylar layer has not provided satisfactory protection against erosion by atmospheric conditions or damage by abrasion or the like. Other attempts have been made heretofore to provide protective coatings for the thermochromic materials. However, many of the prior art protective coatings have had adverse chemical effects on the thermochromic material and have prevented the thermochromic materials from functioning properly. Mylar and other protective coatings have been unable to withstand exposure to atmospheric conditions and have peeled or otherwise become delaminated from the substrate. Thus, none of the prior art protective coatings or thermochromic materials have been entirely satisfactory.

BRIEF SUMMARY AND OBJECTS OF INVENTION

These disadvantages of the prior art are overcome with the present invention and improved protective coatings are provided which are simple and inexpensive to produce and apply and which combine with the thermochromic material to provide temperature-sensitive surfaces which are able to withstand exposure to even severe atmospheric conditions and which strongly resists abrasion, rubbing and other harsh treatment.

These advantages of the present invention are preferably attained by providing an improved protective coating for thermochromic materials comprising a sheet of thermochromic

material bonded to a substrate and coated with a layer of protective liquid which hardens to protect and bond with the thermochromic material and substrate against erosion by atmospheric conditions or abrasion, together with a method for forming such a coating.

Accordingly, it is an object of the present invention to provide an improved thermochromic coating.

Another object of the present invention to provide an improved thermochromic coating which is not subject to damage by atmospheric conditions or abrasion.

An additional object of the present invention is to provide improved thermochromic coatings which are simple and inexpensive to produce and apply.

A further object of the present invention is to provide improved thermochromic coatings which combine with the thermochromic material to provide temperature-sensitive surfaces which are able to withstand exposure to even severe atmospheric conditions.

Another object of the present invention is to provide improved thermochromic coatings which strongly resist abrasion, rubbing and other harsh treatment.

An additional object of the present invention is to provide improved thermochromic articles which can withstand exposure to atmospheric conditions and abrasion.

5 A further object of the present invention is to provide improved methods of applying thermochromic coatings.

10 A specific object of the present invention is to provide an improved protective coating for thermochromic materials comprising a sheet of thermochromic material bonded to a substrate and coated with a layer of protective liquid which hardens to protect and bond with the thermochromic material and substrate against erosion by atmospheric conditions or abrasion, together with a method for forming such a coating.

15 These and other objects and features of the present invention will be apparent from the following detailed description, taken with reference to the figures of the accompanying drawing.

20 BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a flow diagram showing the steps of the method of the present invention for applying thermochromic coatings; and

25 FIGURE 2 is an exploded view showing a typical structure for a sports board.

DETAILED DESCRIPTION OF THE INVENTION

In that form of the present invention chosen for purposes of illustration, FIG. 1 is a flow diagram showing the steps of the method of the present invention for applying the improved thermochromic coatings of the present invention. Thermochromic materials, such as liquid crystals, are gelatin-like materials which are easily torn and are highly subject to damage by abrasion. Accordingly, layers of thermochromic material are conventionally supplied on a supporting layer of stronger material, such as mylar. However, the supporting layers of the prior art do not stand up well against exposure to atmospheric conditions or to strongly abrasive actions. Thus, in accordance with the method of the present invention, the layer of thermochromic material is bonded to a desired substrate by means of a suitable adhesive, such as a resin adhesive. Thereafter, the substrate bearing the thermochromic layer is heated to approximately 100° - 1000° F. at a pressure of up to 1000 psi. for a period of up to 2 hours to cure the adhesive. Next, the supporting layer is peeled off of the thermochromic layer and the article is coated with a protective liquid, such as an acrylic material, and is allowed to air dry for up to 48 hours. When dry, it is found that the protective liquid bonds to the substrate and to the thermochromic layer to form a strong coating which can withstand substantial exposure to even extreme atmospheric conditions and can resist significant abrasive action. Furthermore, it is found that the thermochromic material will change colors at temperatures approximately 10° -

20° lower than before undergoing this treatment, which makes the thermochromic material more suitable for outdoor uses.

Preferably, the thermochromic layer is bonded to the substrate with a suitable resin adhesive and is cured at a temperature of about 350° F at a pressure of approximately 45 psi for a period of one-half hour. Thereafter, the supporting layer is peeled off of the thermochromic layer and the substrate and thermochromic layer are coated, as by spraying, with a protective liquid comprising 0 - 6 parts of a transparent protective liquid, such as acrylic, together with 0 - 5 parts of a suitable catalyst, such as polyisocyanate and 0 - 5 parts of a suitable solvent reducer. A preferred formulation for the protective liquid is 4 parts DCU2021 acrylic with 1 part DU5 catalyst and 1 part DT870 or 885 reducer. The DCU2021, DU5 and DT870 or 885 are available from PPG Industries, 19699 Progress Drive, Strongsville, Ohio 44136. Thereafter, the article is allowed to air dry for up to 48 hours, during which the protective liquid bonds with the thermochromic layer and substrate to form an extremely hard and weather-resistant protective layer.

In use, the method of the present invention has been found to be useful in manufacturing sports boards, such as snow boards, skis, skate boards, surf boards, body boards and the like, as seen at 10 in FIG. 2. These sports boards 10 are usually formed as laminated structures, having a wood core 12 sandwiched between layers 14 of fiberglass. Because the fiberglass layers 14 are porous, they are usually covered by an outer layer 16 formed of a

strong transparent material, such as P-Tex 1500, available from Snow-Tek USA, Inc.,

Traditionally, the protective outer layer 16 is applied to both the top and bottom surfaces of the sports board 10. However, in accordance with the present invention, the outer layer 16 is omitted or removed from the top surface and is replaced with the thermochromic layer 18, which is formed by the method described above and is applied directly to the fiberglass layer 14. When this is done, the thermochromic layer 18 is found to be at least as abrasion-resistant and weather-resistant as the protective outer layer 16 and will change colors in response to temperatures in the range of 10° - 20° F lower than prior to application by the method of the present invention. Also, it has been found that the thermochromic layer 18 can be applied equally well to non-porous substrates, such as metal, using the method described above.

Obviously, numerous variations and modifications can be made without departing from the spirit of the present invention. Accordingly, it should be clearly understood that the forms of the present invention described above and shown in the figures of the accompanying drawing are illustrative only and are not intended to limit the scope of the present invention.

WHAT IS CLAIMED IS:

1 Claim 1. An article of manufacture compri- 1
2 sing: 2
3 a sheet of thermochromic material bonded to 3
4 a substrate, and 4
5 a layer of protective liquid coating said 5
6 sheet and substrate which hardens to protect the 6
7 thermochromic sheet and substrate against erosion 7
8 by atmospheric conditions or abrasion. 8

10 1 Claim 2. The article of Claim 1 wherein: 1
2 said sheet is bonded to said substrate with 2
3 a resin adhesive. 3

15 1 Claim 3. The article of Claim 1 wherein: 1
2 said sheet and substrate are cured at a tem- 2
3 perature of approximately 100° - 1000° F. at a 3
4 pressure of up to 1000 psi for up two hours. 4

20 1 Claim 4. The article of Claim 1 wherein: 1
2 said protective liquid is acrylic. 2

25 1 Claim 5. The article of Claim 1 wherein: 1
2 said thermochromic material is a liquid cry- 2
3 stal. 3

1 Claim 6. The article of Claim 1 wherein: 1
2 said substrate is porous. 2

1 Claim 7. The article of Claim 1 wherein: 1
5 2 said substrate is fiberglass. 2

1 Claim 8. The article of Claim 1 wherein: 1
2 said substrate is non-porous. 2

10 1 Claim 9. The article of Claim 1 wherein: 1
2 said substrate is metal. 2

1 Claim 10. The article of Claim 1 wherein: 1
2 said article is a sports board. 2

15 1 Claim 11. The article of Claim 1 wherein: 1
2 said article is a snowboard. 2

20

25

1 Claim 12. The article of Claim 1 wherein: 1
2 said sheet is bonded to said substrate with 2
3 a resin adhesive, 3
4 cured at a temperature of 350° F and a pres- 4
5 sure of about 45 psi for one-half hour, 5
6 any supporting layer is then peeled off of 6
7 said sheet, and 7
8 said protective liquid comprises: 8
9 0 - 6 parts acrylic 9
10 0 - 5 parts catalyst 10
11 0 - 5 parts solvent reducer. 11

1 Claim 13. The article of Claim 12 wherein: 1
2 said acrylic is DCU2021, 2
3 said catalyst is DU5, and 3
4 said reducer is DT870, 4
5 available from PPG Industries, 19699 Pro- 5
6 gress Drive, Strongsville, Ohio 44136. 6

20 1 Claim 14. The method of producing an article, 1
2 said method comprising the steps of: 2
3 bonding a layer of thermochromic material to 3
4 a substrate, 4
5 curing said layer and substrate at a tempera- 5
25 6 ture of approximately 100° - 1000° F. at a pres- 6
7 sure of up to 1000 psi for up to two hours, 7

8 peeling any supporting layer off of said 8
9 layer, 9
10 coating said layer and substrate with a pro-10
11 TECTIVE liquid which hardens to protect the ther-11
5 12 mochromic sheet and substrate against erosion by 12
13 atmospheric conditions or abrasion, and 13
14 air drying said layer and substrate for up 14
15 to 48 hours. 15

10 1 Claim 15. The method of Claim 14 wherein: 1
2 said protective liquid comprises: 2
3 0 - 6 parts acrylic 3
4 0 - 5 parts catalyst 4
5 0 - 5 parts solvent reducer. 5

ABSTRACT

An improved protective coating for thermochromic materials comprising a sheet of thermochromic material bonded to a substrate and coated with a layer of protective liquid which hardens to protect and bond with the thermochromic material and substrate against erosion by atmospheric conditions or abrasion, together with a method for forming such a coating.

figure 1.

BOND
Thermochromic
layer to
Substrate

APPLY
Heat and
Pressure
to cure

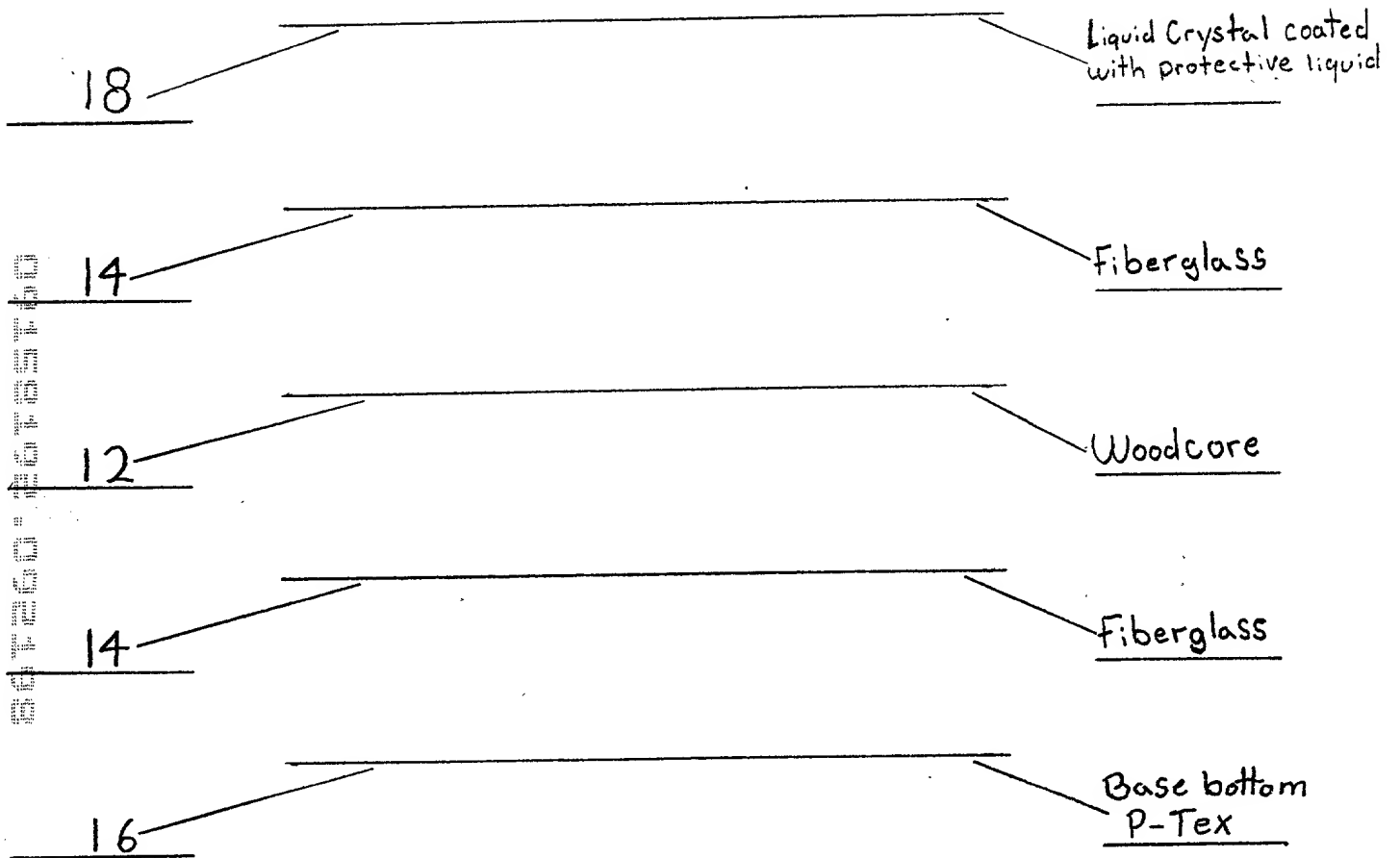
PEEL
Supporting
mylar layer
from
Thermochromic
layer

COAT
Thermochromic
with
protective
liquid

AIR DRY
up to 48
hours

figure 2.

claim 10.



** >Please type a plus sign (+) inside this box → ☐

PTO/SB/01 (3-97)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

☒ Declaration
Submitted
with Initial
Filing

OR

☐ Declaration
Submitted after
Initial Filing

Attorney Docket Number

First Named Inventor

ANTONY J. KUBICHAN

COMPLETE IF KNOWN

Application Number

Filing Date

Group Art Unit

Examiner Name

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

THERMOCHROMIC COATING FOR OUTDOOR USE AND METHOD
OF APPLYING

(Title of the Invention)

the specification of which

☒ is attached hereto
OR

☐ was filed on (MM/DD/YYYY) as United States Application Number; or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

| Prior Foreign Application Number(s) | Country | Foreign Filing Date (MM/DD/YYYY) | Priority Not Claimed | Certified Copy Attached? | |
|--|---------|-------------------------------------|--------------------------|--------------------------|--------------------------|
| | | | | YES | NO |
| NONE | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

| Application Number(s) | Filing Date (MM/DD/YYYY) | <input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto. |
|-----------------------|--------------------------|---|
| 60/059,593 | Sen. 23, 1997 | |

[Page 1 of 2]

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box → ☐

PTO/SB/01 (3-97)
 Approved for use through 9/30/98. OMB 0651-0032
 Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
 Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT International application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

| U.S. Parent Application Number | PCT Parent Number | Parent Filing Date (MM/DD/YYYY) | Parent Patent Number (if applicable) |
|--------------------------------|-------------------|---------------------------------|--------------------------------------|
| NONE | | | |

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Customer Number

OR

☒ Registered practitioner(s) name/registration number listed below

Place Customer Number Bar Code Label here

| Name | Registration Number | Name | Registration Number |
|------------------|---------------------|------|---------------------|
| ROBERT M. SPERRY | 18,053 | | |

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number OR ☒ Correspondence address below

| | | | | | |
|---------|------------------------|-----------|----------------|-----|-------|
| Name | ROBERT M. SPERRY, ESQ. | | | | |
| Address | 23390 Ostronic Drive | | | | |
| Address | | | | | |
| City | WOODLAND HILLS | State | CA | ZIP | 91367 |
| Country | US | Telephone | (818) 225-1011 | Fax | SAME |

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

| | | | | | |
|--|---------------------------|---|----|---------|---------|
| Name of Sole or First Inventor: | | <input type="checkbox"/> A petition has been filed for this unsigned inventor | | | |
| Given Name (first and middle (if any)) | | Family Name or Surname | | | |
| ANTONY J. | | KUBICHAN | | | |
| Inventor's Signature | <i>Antony J. Kubichan</i> | | | Date | 9-21-98 |
| Residence: City | TARZANA | State | CA | Country | US |
| Post Office Address | 19481 Rosita St. | | | | |
| Post Office Address | | | | | |
| City | TARZANA | State | CA | ZIP | 91356 |
| | | Country | US | | |

☐ Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

[Page 2 of 2]<

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(b))--INDEPENDENT INVENTOR

Docket Number (Optional)

Applicant or Patentee: ANTONY J. KUBICHAN

Serial or Patent No.: _____

Filed or Issued: _____

THERMOCHROMIC COATING FOR OUTDOOR USE AND METHOD OF APPLYING

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- ☒ the specification filed herewith with title as listed above.
- ☐ the application identified above.
- ☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern, or organization exists.
- ☐ Each such person, concern or organization is listed below.

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code; and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR

Signature of inventor

Date

NAME OF INVENTOR

Signature of inventor

Date

ANTONY J. KUBICHAN

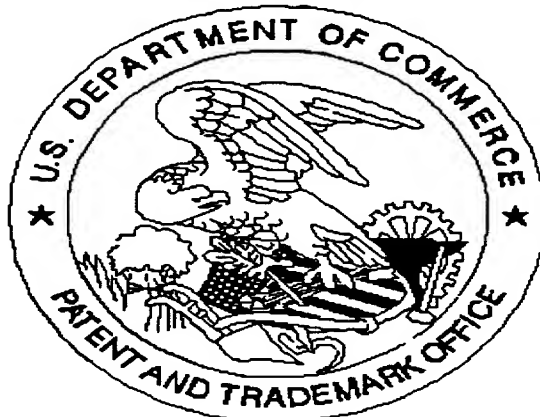
NAME OF INVENTOR

Signature of inventor

Date

United States Patent & Trademark Office

Office of Initial Patent Examination -- Scanning Division



Application deficiencies found during scanning:

1. Application papers are not suitable for scanning and are not in compliance with 37 CFR 1.52 because:
 - ☐ All sheets must be the same size and either A4 (21 cm x 29.7 cm) or 8-1/2" x 11". Pages _____ do not meet these requirements.
 - ☐ Papers are not flexible, strong, smooth, non-shiny, durable, and white.
 - ☐ Papers are not typewritten or mechanically printed in permanent ink on one side.
 - ☐ Papers contain improper margins. Each sheet must have a left margin of at least 2.5 cm (1") and top, bottom and right margins of at least 2.0 cm (3/4").
 - ☐ Papers contain hand lettering.
2. Drawings are not in compliance and were not scanned because:
 - ☐ The drawings or copy of drawings are not suitable for electronic reproduction.
 - ☐ All drawings sheets are not the same size. Pages must be either A4 (21 cm x 29.7 cm) or 8-1/2" x 11".
 - ☐ Each sheet must include a top and left margin of at least 2.5 cm (1"), a right margin of at least 1.5 cm (9/16") and a bottom margin of at least 1.0 cm (3/8").
3. Page(s) _____ are not of sufficient clarity, contrast and quality for electronic reproduction.
4. Page(s) _____ are missing.
5. OTHER: No Transmittal